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A 15th-century Flemish enclosed garden in *cuir bouilli*. Production, degradation and conservation issues of a small painting on leather

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ABSTRACT

An early 15th-century figurative *cuir bouilli* coffret lid, with remains of original polychromy, belonging to the town museum in Nivelles (Belgium), was studied and conserved in 2013. *Cuir bouilli* is the medieval Norman-French term for 'boiled leather'. The technique was widespread in Flanders and Paris in the High Middle Ages. The scene depicted is an 'enclosed garden' with the Virgin and Child. The *cuir bouilli* artefact has been severely damaged by environmental conditions and previous restorations. There are large lacunas in the deformed and hardened leather support, as well as in the pictorial layers. This paper explores the historical context of the artefact, the production of the material, its use and conservation history. Results of reflectance topographic imaging (RTI) are followed by physicochemical analyses and the treatment protocol to stabilise and validate the importance of this lost technique of medieval leatherworking.

ARTISTIC CONTEXT AND ICONOGRAPHY OF THE *CUIR BOUILLI* ENCLOSED GARDEN

The *hortus conclusus* or enclosed garden on the Nivelles *cuir bouilli* panel, a lid of a casket, shows a crowned Virgin and Child, each adorned with a halo, seated between two angel musicians, with an armoured St George, patron of knights, standing outside the enclosure[1] (De Prelle de la Nieppe 1895) (Figure 1). The technique of *cuir bouilli* or boiled leather was popular in Italy, Germany, Paris and Flanders in the High Middle Ages, not only for cup, bottle and relic cases, armour (including parade shields), bookbindings and bookboxes, but also for covering and decorating small, highly sophisticated coffers with chivalric love scenes and other subjects.[2] Paris and Flanders were known for the production and export of these luxury goods through trade routes that reached across Europe (Didier 1978, Cherry 1982). *Cuir bouilli* objects were produced by specialist leather workers, associated with the guild of the *cordoeaniers* (Middle Dutch term derived from the French word *cordouanier)*, and needed skilful craftsmanship. The function of these luxury caskets, known since

Figure 1
Nivelles *cuir bouilli* panel before treatment (2012)

the 19th century as *Minnekästchen* or 'love caskets', was as an engagement or marriage gift to contain books or jewels (Kohlhaussen 1928, Marien Dugardin 1952, Camille 1998). The skilfully shaped, tooled and incised Nivelles *cuir bouilli* panel, measuring 245 × 320 mm, is the sole remnant of such a medieval love casket. Despite the damage to its pictorial layer, its aesthetic and historical importance is still apparent.

Context and hypothetical production stages of the Nivelles *cuir bouilli* panel

Cuir bouilli is a process used to change flexible, vegetable-tanned leather into rigid, moulded and often intricately shaped objects (Davies 2006). For shaping of the vegetable-tanned leather, heat and moisture were used, as indicated by the term 'boiled leather'. No written medieval sources describing the production of decorated *cuir bouilli* objects survive, so knowledge of the process relies on the important studies of the Scottish leather historian John William Waterer (Waterer 1981 and 1986). More recently, Davies and Payton (2001) described at least three different ways to make *cuir bouilli*. Experimental reconstructions of *cuir bouilli* objects, using different recipes, by a group of leather conservators and craftsmen (Neno et al. 1995, Carlson 2003), found that the leather used would be half or fully tanned and that, in response to different requirements, a large range of methods, materials and techniques could be used in varying combinations.

The hypothetical production stages for relief images like the Nivelles *cuir bouilli* panel could be as follows: the vegetable-tanned leather, made supple with moisture and heat, was stuffed, shaped and nailed to the rigid wooden coffer support. The stuffing material was probably modelled beeswax or stearin wax. To shape the leather, to create its topography, 'cushions' were possibly made by lacing a thread through an awl hole and attaching the flexible leather and stuffing to the rigid wooden support on the bottom. Then the decoration was done: lines were incised through the upper layer of the leather (epidermis) with different thicknesses of knives or needles. Contours were created with deep v-shaped cuts (e.g. the St George figure), decoration with thin incisions (e.g. the leaves of the trees) and final details with a needle point (e.g. the eyes of the figures). On the Nivelles panel, an iron-gall ink was very probably applied to darken the surface (see the analytical results below). For the incision and pouncing stage, the leather was probably kept heated and moistened for suppleness. Once dry, the leather would be hard and rigid. Next, gold and silver foils were applied (e.g. on the halo and the crown of the virgin, on the armour of St George and on the sky background). This was followed by pouncing the leather in the sky with heated metal hand tools, or punches (e.g. the little round shapes in the upper area). Finally, polychrome layers were painted on the leather with a brush and finished with small red and white dots (e.g. the little red dots for the cherries or apples (?) in the trees). No varnish was added by the *cordouaniers*, but probably a wax layer.

Shape and tool identification with reflectance transformation imaging (RTI)

For better plotting and understanding of the moulding of, and incisions in, the *cuir bouilli*, the panel was digitized with omnimulti-directional

Figure 2
RTI imaging of a detail of the *cuir bouilli* panel with the shaded filter and the height profile revealing the topography of the surface

Figure 3
Before treatment, detail: 19th-century intervention – a lacuna in the centre part between the Virgin and Child, filled in with plaster and gold-coloured paint

lighting. The technique of the RICH Project portable mini-dome is based on reflectance transformation imaging (RTI), a technique of imaging and interactively displaying objects under 260 varying lighting conditions to reveal surface phenomena (Watteeuw et al. 2013). The shaded and the sketch filters were able to reveal the image and its topography very exactly. The xyz height profile and measuring tool monitored 40 mm depth variance in the panel. The highest point of the topography is the arm of the Virgin, the lowest points are the outer edges. The main v-shaped incisions are 1 mm wide and 0.85 mm deep (e.g. the contour lines of the figure of St George), smaller lines are 0.7 mm wide (e.g. the horizontal lines in the fence) and, finally, the incisions creating St George's fine hair are 0.5 mm wide and less deep at 0.4 mm. The circular hand tool, or punch, used for the background has an inner diameter of 1.8 mm. The little circles were hand pressed with great regularity, as 21 of them show a variation in depth of between only 0.87 and 0.89 mm. The observations with the RTI technique gave remarkably precise information on the craftsmen's tools: it was possible to define with certainty three different knives used to incise the image, and one small hand punch used to complete it (Figure 2).

DAMAGE AND 19TH-CENTURY RESTORATION HISTORY

Preserved in isolation, the Nivelles leather panel has lost its original function and context as the lid of a wooden casket. Before the first large retrospective exhibition on medieval art, held in Brussels in 1880 – where the *cuir bouilli* object was displayed for the first time – it had been severely damaged, fire being mentioned in a 19th-century source.[3] In the period of the Neo-Gothic revival in the second part of the 19th century, exhibitions of medieval art became very fashionable in Europe; the 1880 Brussels event, in celebration of the 50th anniversary of Belgian independence, was an important stimulus to display, and also to 'restore', medieval objects. Occasionally, the interest in medieval craftsmanship resulted in invasive restoration approaches, as was the case for the Nivelles *cuir bouilli* panel.

The examination in 2012 allowed the authors to reconstruct the following 19th-century restoration history: the leather fragments of the panel were glued and attached with nails at the edges to a recycled oak panel, probably from a piece of furniture. The shaped structure of the *cuir bouilli* was strengthened by adding stuffing material, a yellowish plaster, to fill out the curved shapes of the leather. For aesthetic reasons, a gold-coloured paint was applied to mask the plaster visible through the large lacunas in the leather in the centre of the Virgin and Child (Figure 3). The severely damaged polychromy on the figures was not retouched. The entire surface of the leather was finished with a coating, probably of beeswax. Pyrolysis-GC/MS of a leather sample revealed a large amount of fats and/or wax.

After the prestigious Brussels exhibition of 1880, the object was returned to the museum at Nivelles to be placed in a box in a drawer and forgotten. For 130 years, the object was stored in an overly dry environment. This caused the leather to shrink and break in several places, specifically in the most fragile areas where the incisions in the leather are deepest. The cross section of a sample (SEM backscattered image) documents the

Figure 4
Before treatment, XRF analyses with the Artax (Bruker)

extreme fragility of the leather (Figure 6). The surface wax layer on top of the leather became tacky and brownish.

Analysis of the pictorial layers

To investigate the materials used to paint the scene, it was decided to use mainly non-destructive analysis techniques because of the unique and fragile character of the object. Non-invasive x-ray fluorescence analysis was used to reveal the craftsman's palette[3] (Figure 4). In addition, some small samples were taken for complementary µ-Raman analysis[4] and to illustrate the paint-layer buildup.[5]

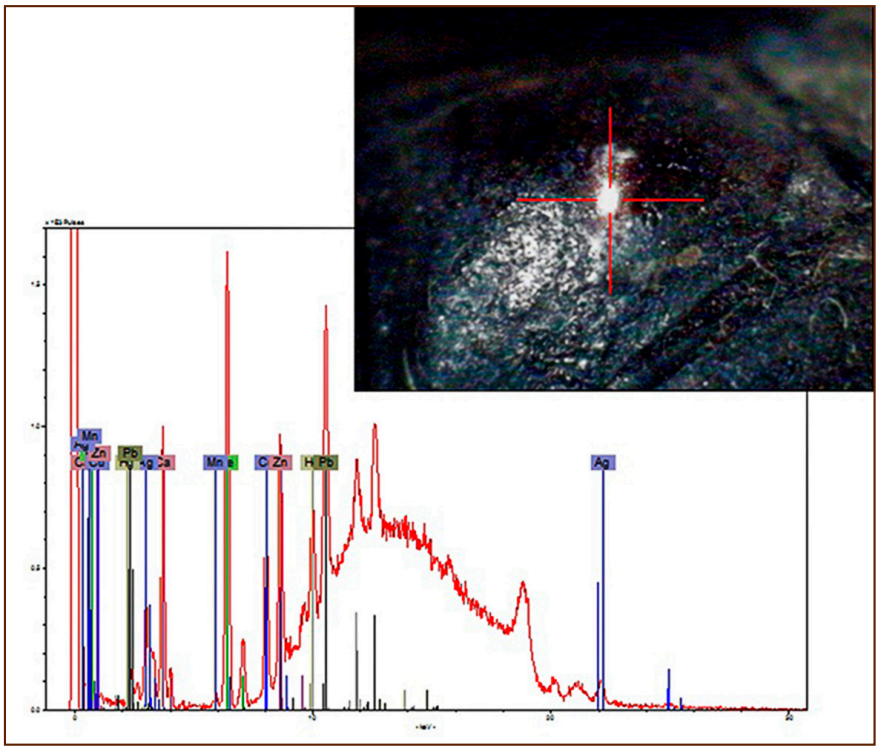

Figure 5
XRF measurement of the silver foil on the armour of the knight. As the x-ray beam penetrates the silver foil, not only is the foil measured but also the underlying layers (Mn, Fe, Cu and Zn are indicative of the iron-gall ink used to darken the leather)

All red parts in the painted scene are vermillion based. The red paint layer is applied directly onto the leather support as evidenced by a paint cross section (Figure 5). The flesh tones contain vermillion in combination with lead white. Lead white is used for the white dots on the angel's robe and for Mary's veil. Lead white in combination with orpiment is used for the pale yellow dress of the Virgin. Analysis of the yellow colour of the fence also shows the presence of orpiment. Moreover, orpiment was present in all analysed vegetation areas (like the leaves of the trees or the grass). Although now hardly discernible, the original colour must have been green, meaning that a blue pigment must be present as well as the yellow orpiment. Indigo was recommended by Cennino Cennini: 'A mixture of some of this color (orpiment) with Bagdad indigo gives a green color for grasses and foliage'. The presence of indigo was confirmed by subsequent µ-Raman analysis of a sample taken from the leaves of the tree in the upper left corner. The bright paint layers were enhanced by gold and silver leaf. Silver leaf was used for the armour of St George (Figure 5).

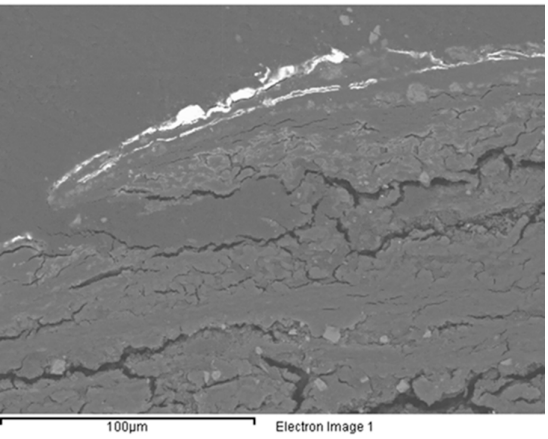

Figure 6
SEM backscattered image of a cross section prepared from a sample taken from the top of the panel at the centre

Figure 7
Mending of the broken incisions with Japanese paper (Kozo fibres) and vegetable-tanned leather

The silver leaf, which has now turned almost completely black, originally added to the splendour of the object. A cross section of a sample from the background at the top revealed two layers of metal: the underlying one is gold leaf, the upper one is silver leaf (Figure 6). It is hard to deduce why these two layers were superimposed onto the leather. In some areas of the *cuir bouilli* panel, no paint is applied, meaning that the colour of the leather forms part of the completed image. As evidenced by XRF analysis, the leather was darkened using iron-gall ink (elements Fe, Cu and Zn).

These analyses revealed that the pigments used for painting on the leather are closely linked to the palette used for panel painting in the Low Countries at the beginning of the 15th century. In this context, the Nivelles enclosed garden is a rare addition to the corpus of works in the so-called pre-Eyckian painting tradition.

CONSERVATION TREATMENT

Removing previous 19th-century restoration materials

The main aim of the treatment was to stabilize the structural and visual integrity of the *cuir bouilli* panel (Thomson and Kite 2006). A large part of the 19th-century plaster between the leather and oak board was broken into small fragments and removed mechanically through the lacunas, using large needles and spatulas. Some minor recent interventions (post-1950), like small patches in Sellotape, were easily removed mechanically.

Surface treatment

The option of dismounting the *cuir bouilli* from the wooden support was rejected as too invasive; an in-situ treatment was deemed preferable. After high-resolution documentation and material analyses, tests were executed to evaluate the flexibility of the extremely hard leather by local relaxation with the ultrasonic mister and Gore-Tex patches. These tests produced no results, as the hardened leather has no hygroscopic characteristics left (Thomson and Kite 2006).

A second group of tests was performed with solvents to remove the 19th-century sticky, greasy wax layer on the surface, as it was encrusted with dirt particles and fibres. Ethyl methyl ether with cotton swabs gave excellent results for the upper surface, removing a part of the wax. Great care, however, was taken in order to minimize the risk of removing any of the original coating of the *cuir bouilli* (Davies and Payton 2001). Moreover, the tests revealed that the red vermillion used to paint the border and the wings of the angels was not stable for solvents. During this cleaning, the surface cleared considerably. Mechanical cleaning was then done with a soft, thin wooden rod inserted into the v-shaped incisions in the leather. Under the binocular microscope, the wax in each incision could be gently ‘peeled out’. The results of the mechanical cleaning were even more revealing, as the pigment particles were better preserved in the incisions. It became possible, for example, to see the yellow orpiment in the incised lines of the wattle fence. After cleaning, the general visibility of the polychrome surface was significantly improved, although only the remarkably well-preserved red colour has survived unaltered. The next

step was a minimal treatment with a leather lubricant on a textile swab (BMLD: anhydrous lanolin, cedarwood oil, refined beeswax, hexane), taking off more darkened, sticky 19th-century beeswax.

STRUCTURAL TREATMENT

A side effect of the cleaning with the small textile swab was that the lubricant slightly softened the leather's fractured edges. The edges could then be manipulated gently downwards and fixed in different stages with textile tension strips to get them into a more desirable position.

For mending the incisions that had broken right through the leather, two materials were selected: Japanese paper (Kozo fibres) and vegetable-tanned leather (Hewitt & Sons, Scotland/Illustration 7). Where the incisions were open for a width of 1 to 2 mm, but without loss of original material, toned Japanese paper was used to fill the gap, affixed to both sides with Tylose MH 300 (4%). The edge of the Virgin's robe, for example, was attached to the background with small strips of Kozo fibres fastened to the inner sides of the leather. The next step was to fill the 'topographical' lacunas. This was achieved with small patches of synthetic fabric, shaped three dimensionally and enveloped in Hollytex. Where required, these patches were inserted between the wood and the leather with small spatulas; they stayed in place without the use of adhesives. The lacunas, such as the large area missing from the central part of the wattle fence at the bottom edge, were filled with toned vegetable-tanned calf leather, carefully cut in the shape of the missing area. The adhesive was Tylose 4%. Finally, the irregularly cut borders of the panel were completed with a brown-toned strip of Japanese paper (Eukesolar 150 F). In this way, the visual integrity of the image was again established. The option of 'inpainting' the lacunas in the pictorial layer was discussed, but rejected (Figure 8).

Figure 8
Nivelles *cuir bouilli* panel after treatment (2013)

CONCLUSION

Very few coffrets have been scientifically examined and conserved. The research and treatment of the *cuir bouilli* coffret lid was able to validate the importance and beauty of this kind of medieval artefact. The pigment analyses showed that the coffret lid was once splendidly colourful. The pigments used for the polychromy on the leather are closely linked to the palette used for panel painting in the Low Countries at the beginning of the 15th century. The assessment of the topography and the pictorial layers guided the cleaning of the surface. As a result of the treatment, the Nivelles coffret lid now demonstrates why the lost technique of *cuir bouilli* was so valued in medieval Europe.

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NOTES

[1] Nivelles (Nijvel) is a small town in the south of the province of Brabant, Belgium. The *cuir bouilli* panel was donated before 1880 to the learned society established by the local savants in September 1876: *La Société royale d'Archéologie, d'Histoire et de Folklore de Nivelles et du Brabant wallon*. The town museum, Musée communal d'archéologie, d'art et d'histoire, was established on 7 October 1883 for the display of archaeological and medieval artefacts and for teaching local history.

[2] The first examples of decorated *cuir bouilli* containers apparently date from the 12th century and the technique flourished until the 17th century. In Italy, there was a large production of cases for cups and books (e.g. missal cases); in Germany, Bohemia and Hungary the technique was largely used in the 14th and 15th centuries for bookbindings.

[3] A note in the museum records mentions a fire pre-1880, before the artefact entered the museum, although no carbonization traces could be found on the leather panel.

[4] XRF analyses were done using the Artax (Bruker) (Rhodium source, 50 kV, 500 µA, 25 µm Mofilter during 120 seconds); µ-Raman analyses were done using a Renishaw Invia Raman spectrometer with a 785 nm laser.

[5] For the paint cross sections, the samples were glued between two plexi cubes using an acrylic adhesive. After polishing of the cross section, images were taken using a Zeiss AxioImager optical microscope and a Jeol JSM6300 scanning electron microscope.

MATERIALS

Vegetable-tanned calf leather. Hewitt & Sons, Scotland

Japanese handmade paper: Kozo fibres, K 37, NAO paper, Tokyo, Japan.
Supplier: Route du Papier, Brussels

British Museum Leather Dressing: anhydrous lanolin, cedarwood oil, refined beeswax, hexane. Supplier: Route du Papier, Brussels

Tylose® MH 300, Methyl 2-hydroxyethyl cellulose. SE Tylose GmbH & Co. KG

Eukesolar® 150 F, brown. BASF

XRF analyses
Artax (Bruker) (Rhodium source, 50 kV, 500 µA, 25 µm Mo filter during 120 seconds)

µ-Raman
Renishaw Invia Raman spectrometer with a 785 nm laser

Microscopy
Zeiss AxioImager optical microscope and a Jeol JSM6300 scanning electron microscope

Pyrolysis-GC/MS
Pyrolysis unit from FrontierLab; Trace GC ultra and a PolarisQ mass spectrometer both from Thermo

Reflectance transformation imaging (RTI)
KU Leuven RICH (Reflecting Imaging for Cultural Heritage) Project, portable mini-dome.

Illuminare & ESAT,
Blijde Inkomststraat 21, 3000, Leuven, Belgium: www.illuminare.be/rich_project

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